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USING SATELLITE IMAGERY TO ASSESS THE INFLUENCE OF RECENT URBAN DEVELOPMENT ON THE IMPACTS OF EXTREME RAINFALL

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EXTENDED SUMMARY

INTRODUCTION

In recent years it has been widely demonstrated that cities globally have become increasingly exposed and vulnerable towards the occurrence and impacts of floods (Field et al., 2012). This is partly due to the dramatic increases in the extent of urban land cover throughout the past century (Angel et al., 2011) and rapidly growing concentrations of people, assets and economic activities in urban environments. Urban environments tend to be highly dominated by impervious surfaces, as road infrastructure, buildings and other paved areas occupy a predominant share of the urban land area (Weng, 2008). Increases in impermeable areas have important implications for the hydrological response of a catchment through a reduction in infiltration capacity and surface storage capacity and a decrease in evapotranspiration. Moreover, this leads to a loss in the natural water retention capacity and subsequently exaggerated run-off volumes, discharge rates and flood peaks (Butler, 2004).

Satellite imagery and remote sensing techniques offer a complete spatial and temporal coverage of urban land cover changes during the past 30-40 years and may be used to investigate the relationship between urban land cover changes and the risk towards the occurrence and impacts of flooding. In this paper we outline a data driven modelling approach to investigate the potential of medium resolution satellite imagery for examining changes in the hydrological response and the potential impacts of pluvial flooding due to recent urban development. The aim is to develop a methodology to enable systematic investigations of risk changes and the identification of the main factors influencing the degree of risk of flooding in urban areas due to high intensity rainfall events.

METHODOLOGY

Figure 1 shows the proposed methodological framework, which serves as our systematic basis for investigating and quantifying changes in flood risk for urban areas. The framework is organised around three major analytical and modelling components: urban remote sensing analysis, hydrological modelling and spatial impact modelling. The three components are all interconnected as described in the figure, i.e. the output of one element feeds into the next element, starting from left to right. T1 (e.g. 1980, which is about the earliest point in time, where satellite imagery appropriate for urban analysis is available) and T2 (e.g. today) refer to different points in time during which the change in risk will be investigated.

The urban remote sensing analysis consists of two separate tasks, (1) classification of urban land cover/land use and (2) impervious surface mapping, and will be conducted using 30 meter resolution Landsat imagery (<http://landsat.gsfc.nasa.gov/>). The output from the impervious surface mapping offers pixel-based information on urban runoff characteristics, which feeds into a hydrological model, whereas the output of the land cover classification analysis is used as input for the spatial impact model. The primary land cover/land use variables of relevance include buildings, road infrastructure, recreational areas and waterways. The urban hydrological modelling is performed using the MIKE by DHI 1d/2d MIKE Urban/MIKE Flood modelling system. Combining the storm-water drainage network model with urban elevation characteristics enables the evaluation of the flood risk during user defined

rainfall events. The main output from the hydrological model is a hazard map showing the extent and depth of flooding during a specific event, which is combined with land cover/land use information in a GIS based spatial impact model containing information on the main socioeconomic variables (population, traffic volumes, etc.). Comparing the results of the hydrological and spatial impact modelling for two different points in time (T1 and T2) allows for a quantitative assessment of the influence of urban land cover changes on the risk towards the impacts of pluvial flooding.

The applicability of the methodological framework is demonstrated using the city of Odense as an initial case study. Odense is situated in the central parts of Denmark on the island of Fyn and has a population of approx. 170.000 inhabitants, making it the third largest city in Denmark.

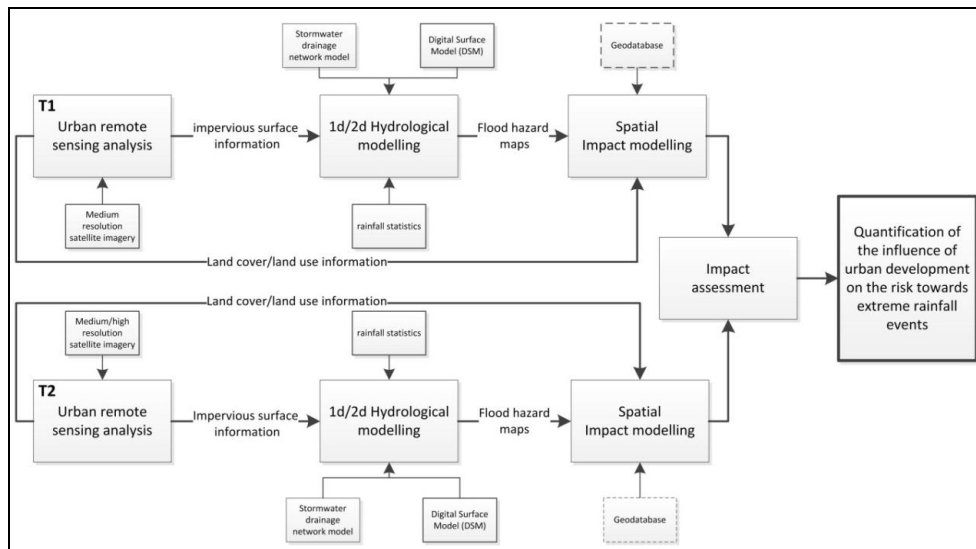


Figure 1: Overview of methodological framework

PERSPECTIVES AND CONCLUSIONS

New and improved remote sensing techniques and the ready availability of high-resolution satellite imagery may contribute to the identification and quantification of the main indicators responsible for changing the risk of urban areas towards pluvial flooding. To explore the potential for integrating remote sensing data directly into hydrological and spatial models in an urban context, a novel methodology has been proposed. The expected results of this work are likely to provide important insight into the relative importance of the primary factors (urban land cover changes and climate change) affecting the exposure and vulnerability of urban areas to floods; and to support the planning for future climate proof cities (Field et al., 2012).

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